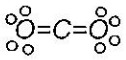
- *Use lines to represent bonding pairs of electrons*
- *Use dots to represent lone pairs of electrons*

**Determining the Structure of a Molecule**

*General Rules for Positioning Atoms*

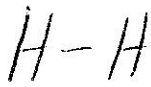
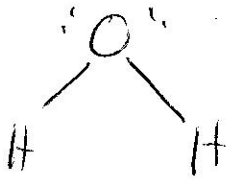
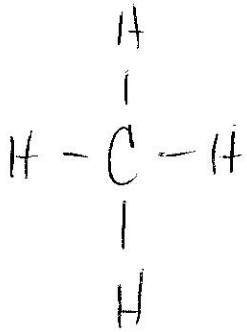
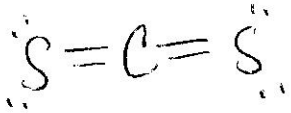
1. *Hydrogen is always a terminal (end) atom which is binds to atoms other than another hydrogen (unless the molecule is $H_2$)*
2. *The atom with the lowest electronegativity (more metallic character) is centered in the molecule.*

*Example: $CO_2$* 

*Determining the Number and Position of Electrons in a Molecule*

*Often, the arrangement of electrons in a molecule is obvious. Unpaired electrons in each atom form bonds between the atoms and lone pairs remain with their respective atoms. In more complex structures, lone pairs of electrons may be used in the bonding of two atoms (coordinate covalent bonding).*

*Obvious Covalent Bond Examples*

| | | |
|---|---|---|
| $H_2$  | $H_2O$  | $CH_4$  |
| $O_2$  | $CS_2$  | $N_2$  |

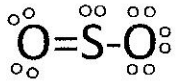
*Strategy for Complex Structures*

1. *Determine the total amount of electrons that would be present if each atom had its own octet of electrons (exception: only two electrons for hydrogen).*
2. *Determine the total number of valence electron for the atoms in the molecule.*
3. *To determine the number of bonding pairs (electron pairs that will go between the atoms) calculate the difference between the number of electrons in step one and two and divide that number by 2.*
4. *Place the pairs of electrons between the atoms.*
5. *Add enough lone pairs to the molecule so that each atom follows the octet rule.*

**Structure Table**

| $SO_2$ | *Total Electrons* | *Valence Electrons* | *Bonding Pairs* |
|---|---|---|---|
| *Calculation* | *3 atoms x 8 electrons each* | *(1 sulfur x 6 electrons) + (2 oxygens x 6 electrons)* | *(24 -18)/2* |
| *Answer* | *24* | *18* | *3* |

*Structural Formula:*

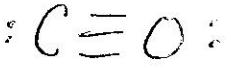


**HINT:** *To make sure that you have bonded the atoms in the molecule correctly, make sure that each atom has a full octet (with the exception of hydrogen) and that only the amount of valence electrons were used)*

**Fill in the tables and draw the Lewis formula for the following compounds**

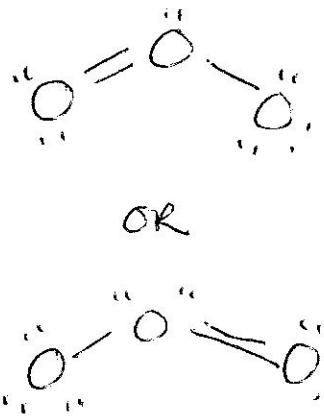
| $CO$ | *Total Electrons* | *Valence Electrons* | *Bonding Pairs* |
|---|---|---|---|
| *Calculation* | ~~2~~ 8 | 4+6 | (16-10)/2 |
| *Answer* | 16 | 10 | 3 |

*Structural Formula:*



| $O_3$ | *Total Electrons* | *Valence Electrons* | *Bonding Pairs* |
|---|---|---|---|
| *Calculation* | 3x8 | 3x6 | (24-18)/2 |
| *Answer* | 24 | 18 | 3 |

*Structural Formula:*

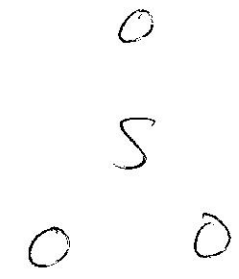


OR



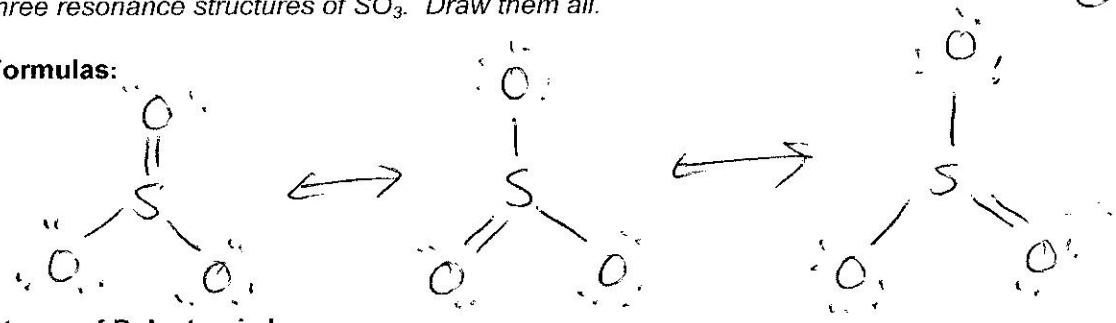
2 Resonance Structures

| $SO_3$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 4 x 8 | 6 + 18 | (32-24)/2 |
| Answer | 32 | 24 | 4 |



*There are three resonance structures of $SO_3$. Draw them all.

**Structural Formulas:**



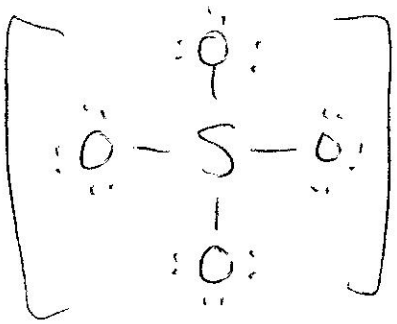
**Lewis Structures of Polyatomic Ions**

*Follow the same procedure as you do for complex molecular compounds, except add a number of valence electrons equal to the charge on the ion to the total number of valence electrons in the compound (for positive ions subtract the number of electrons equal to the charge number)*

*Example* $SO_4^{2-}$

| $SO_4^{2-}$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 5 atoms x 8 electrons each | (1 sulfur x 6 electrons) + (4 oxygens x 6 electrons) + **2 gained electrons** | (40 -32)/2 |
| Answer | 40 | 32 | 4 |

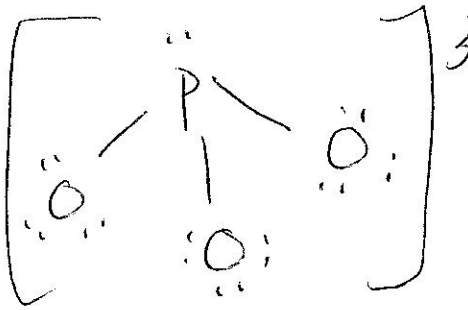
Structural Formula:



**Fill in the tables and draw the Lewis formula for the following compounds**

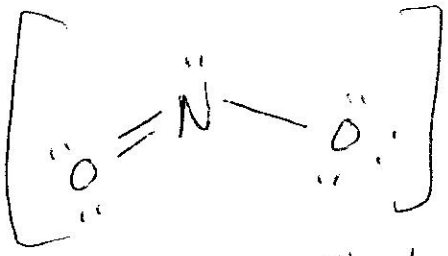
| $PO_3^{3-}$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 4 x 8 | 5 + (3x6) + 3 | (32-26)/2 |
| Answer | 32 | 26 | 3 |

Structural Formula:



| $NO_2^-$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 3x8 | 5 + (2x6) + 1 | (24-18)/2 |
| Answer | 24 | 18 | 3 |

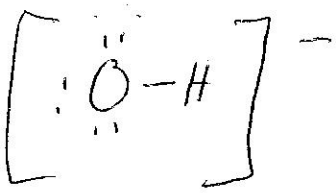
Structural Formula:



2 resonance structure

| $OH^-$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 8+2 | 6+1+1 | (10-8)/2 |
| Answer | 10 | 8 | 1 |

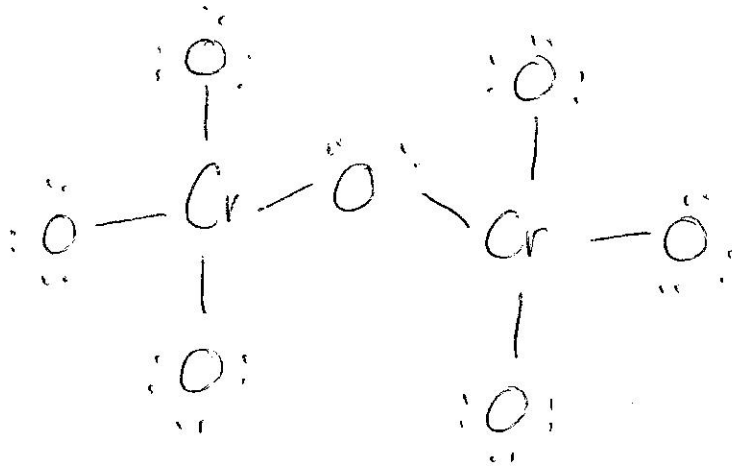
Structural Formula:



For fun ☺ In this case chromium has 6 valence electrons.

| $Cr_2O_7^{2-}$ | Total Electrons | Valence Electrons | Bonding Pairs |
|---|---|---|---|
| Calculation | 8x9 | (2x6) + (6x7) + 2 | (72-56)/2 |
| Answer | 72 | 56 | 8 |

Structural Formula:



# Naming Molecular Compounds

**Naming Rules**

1. If there is more than one of the 1st atom, precede the atom name by the appropriate prefix (di, tri, tetra, penta, hexa, hepta, octa, nona, deca)

   Example: $C_6O_2$ hexacarbon dioxide

2. If there is only one of the first atom, do not precede the atom name by mono.

   $CO_2$ = monocarbon dioxide $CO_2$ = carbon dioxide

3. Precede the second atom name by the appropriate prefix, including mono if there is only one of that atom. Drop the last syllable (or 2) and add –ide to the element name

   $C_2O$ Dicarbon monoxide

| Element | Name | Element | Name |
|---|---|---|---|
| C | Carbide | S | Sulfide |
| N | Nitride | Cl | Chloride |
| O | Oxide | Se | Selenide |
| F | Fluoride | Br | Bromide |
| P | Phosphide | I | Iodide |

**Provide the name of the following molecular compounds**

| Compound | Compound Name |
|---|---|
| $P_6O_3$ | Hexaphosphorus trioxide |
| $NS_4$ | Nitrogen tetrasulfide |
| $Se_8O$ | Octaselenium monoxide |
| $C_7Br_5$ | heptacarbon pentabromide |
| $S_2F_2$ | disulfur difluoride |

**Provide the Chemical Formulas given the following names**

| Compound Name | Compound |
|---|---|
| Dinitrogen monofluoride | $N_2F$ |
| Nonaphosphorus decachloride | $P_9Cl_{10}$ |
| Sulfur hexabromide | $SBr_6$ |
| Tetracarbon pentasulfide | $C_4S_5$ |
| Octanitrogen trifluoride | $N_8F_3$ |